BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to electric toothbrushes and, more particularly, to an electric toothbrush providing dual action bristle motion and, more specifically, oscillating motion of bristles about an arc of rotation and simultaneous reciprocating motion of the bristles away from and back towards the toothbrush head to create a pumping-type action for effectively cleaning tooth surfaces and inter-proximal crevices between teeth.

Discussion of the Related Art

The benefits of brushing one's teeth using motorized toothbrushes are well known, and motorized movement in toothbrushes has been the subject of much recent innovation and design activity. Also, the commercial market has seen the introduction, over the last several years, of many different types of motorized toothbrushes. However, an examination of the available technology shows a tendency toward increasingly complex, expensive, and non-commercially feasible methods of achieving motorized motions in the bristles and heads of toothbrushes to aid in more effectively cleaning one's teeth.

The commercial marketplace has become divided into two price markets. On the higher priced end are some of these more complex motorized toothbrushes that provide various motions to the bristles and brush head. The lower end of the market has become the province of very simple motorized toothbrushes that only vibrate through the use of an offset weight attached to the motor shafts and which provide very little true additional cleaning benefit with their use, since no vigorous motion is transmitted to the cleaning surface of the brush. The vibrations are

also very uncomfortable to the hand and act to discourage brushing one's teeth for an adequate period of time.

Numerous electric toothbrushes have been developed over the years. Some known devices are shown in U.S. Patent Nos. 5,070,567; 5,186,627; 5,274,870; 5,341,534; 5,378,153; 5,732,433; and 6,360,395. The disadvantage of these devices is that bristles lack an up and down movement relative to the brush head and therefore perform less than optimal in cleaning tooth surfaces. Another disadvantage is that these devices lack bristle arrangement to clean hard-to-access crevices between teeth. The device shown in U.S. Pat. No. 6,574,820 discloses an embodiment in which an inter-dental probe moves up and down relative to a second set of bristles. This embodiment provides enhanced cleaning of the crevices between tooth surfaces. However, the disadvantage is that the inter-dental probe does not rotate (thereby does not provide the benefits of bristle twisting motion). Another disadvantage is that the second set of bristles does not move up and down (thereby does not provide the additional cleaning benefits resulting from a pumping up-and-down oscillating motion of bristles on tooth surfaces). Accordingly, it has been considered desirable to develop a new and improved electric toothbrush which would overcome the foregoing difficulties and others while providing better and more advantages.

Summary of the Invention

The present invention is directed to a toothbrush head which provides a dual action bristle motion, including an oscillating motion and a simultaneous linear reciprocating motion of at least one set of bristles. In several preferred embodiments, the brush head is adapted for use with an electric toothbrush having an elongated body with a hollow interior defining a housing.

The elongated body includes a handle portion, a head and a neck extending between the handle portion and the head. A motor contained and supported within the handle portion is disposed in driving engagement with a drive assembly. The drive assembly includes a swivel arm arrangement having a distal end disposed within the head portion of the elongated body. The swivel arm arrangement is operatively driven by the motor to move the distal end in a reciprocating motion. A bristle member is fitted to the head portion of the elongated body and is movable about a central rotational axis.

The bristle member includes a first portion movably captivated within the interior of the head portion of the housing, and a second portion disposed on an exterior of the bottom face of the head. The second portion of the bristle member includes a bristle support structure with a first set of bristles extending outwardly therefrom and arranged in a generally circular pattern about the central rotational axis. A motion directing assembly is structured and disposed for moving the bristle support structure and the attached first set of bristles in an oscillating motion through an arc of rotation about the central rotational axis. The motion directing assembly is further structured for simultaneously directing the bristle support structure and the attached first set of bristles in a linear reciprocating motion away from and back towards the bottom face of the head portion and generally parallel to the central rotational axis.

In several further embodiments of the invention, a second set of bristles is movably supported on the head portion and the motion directing assembly is structured and disposed for simultaneously moving both the first set of bristles and the second set of bristles, wherein both sets of bristles oscillate in opposite directions about the central rotational axis, while simultaneously moving in the linear reciprocating motion. When moving in the linear reciprocating motion, the first set of bristles moves in the opposite direction to the second set of

bristles so that when the first set of bristles is raised towards the head, the second set of bristles is lowered away from the head, and when the first set of bristles is lowered away from the head, the second set of bristles is raised towards the head.

In still further embodiments of the invention, multiple first and second sets of bristles are provided and arranged in corresponding pairs, with each pair consisting of a first set of bristles and a second set of bristles. The first and second sets of bristles in each pair are driven by the motion directing assembly in both the oscillating motion and linear reciprocating motion, in opposite directions, in a manner similar to the previously described embodiments.

Objects and Advantages of the Invention

It is a primary object of the present invention to provide a controlled and predetermined oscillating up-and-down motion of bristles in a motorized toothbrush, thereby creating a pumping-type action to effectively clean tooth surfaces and access difficult-to-reach crevices between the teeth.

It is a further object of the present invention to provide a motorized toothbrush with two sets of bristles moving in an up-and-down manner (in opposite directions from one another) while oscillating/rotating (in opposite directions from one another) and wherein the first set of bristles extends to its maximum length to effectively penetrate crevices between the teeth while the second set of bristles withdraws to its minimum length to allow the first set of bristles to achieve maximum penetration and further where the first set of bristles withdraws to its minimum length while the second set of bristles extends to its maximum length to effectively clean tooth surfaces.

It is still a further object of the present invention to provide a motorized toothbrush with two sets of bristles and wherein the bristle sets are moved in an alternating up-and-down action while each oscillating set of bristles rotates, thereby providing a unique and superior cleaning action that targets both tooth surfaces and inter-proximal crevices between teeth.

Other objects, features, and advantages of the invention will become apparent upon reading the following detailed description in conjunction with the accompanying drawings.

Description of Drawings

For a fuller understanding of the present invention, reference should be made to the following detailed description taken in conjunction with the accompanying drawings in which:

Figure 1 is a perspective view in accordance with the first preferred embodiment of the present invention;

Figure 1B is an exploded view illustrating relation of disk with brush head floor;

Figure 1C is a front view illustrating the bristles in an up position;

Figure 1D is a front view illustrating the bristles in a down position;

Figure 2A is an exploded view illustrating relation of disk with top of brush head;

Figure 2B is an exploded view of alternate embodiment illustrating relation of disk with top of brush head;

Figure 3 is a side view illustrating relationship of disk with wall of brush head;

Figure 4A is an exploded view illustrating relation of disk with brush head floor;

Figure 4B is a side view of disk illustrating position of protruding feet;

Figure 4C is a bottom plan view of brush head floor;

Figure 4D is a front view with bristle in an up position;

Figure 4E is a front view with bristle in a down position;

Figure 6C is a front view illustrating first set of bristles in an up position and second set of bristles in a down position;

Figure 6D is a top plan view;

Figure 6E is a bottom plan view;

Figure 6F is an exploded view;

Figure 7 is an exploded view;

Figure 8A is an exploded view;

Figure 8B is a top plan view;

Figure 8C is a front sectional view taken along line 8C-8C in Fig 8B;

Figure 8D is a side view;

Figure 9A is a top plan view;

Figure 9B is a front view;

Figure 9C is a side view illustrating relation of rack with drive gears;

Figure 10A is a perspective view;

Figure 10B is a top plan view;

Figure 10C is a front view;

Figure 10D is a side view.

Detailed Description of the Preferred Embodiments

Figure 1 illustrates an electric toothbrush 100 which has an elongated body 30. A first end 27 of the elongated body 30 has a head 23 and the opposite second end 32 defines a handle

33. The elongated body portion 30 further includes an angled neck 29 which is located between the head 23 and the handle 33. Angled shaft 29 is parallel with the longitudinal axis 39 of the elongated body portion 30. The elongated body portion 30 also includes a hollow portion 31 which houses a motor 1. The motor 1 provides power to the bristle supporting structure 24 to rotate in an oscillating action. Power is provided to the motor by a battery (not shown).

A first gear 2 is operatively connected to and powered by the motor 1. The first gear 2 rotates about the longitudinal axis 39. A second gear 4 is operatively connected to the first gear 2. The second gear 4 is approximately normal to the first gear 2. The second gear 4 is preferably a bevel gear and rotates about an axis approximately perpendicular to the longitudinal axis 39. Teeth 3 of the first gear 2 mesh with teeth 5 of the second gear 4 causing second gear 4 to rotate when first gear 2 rotates.

A swivel arm arrangement is linked between the second gear 4 and the bristle supporting structure 24. In a preferred embodiment, the swivel arm arrangement includes a first swivel arm 7, a second swivel arm 9 and a third swivel arm 16. The first swivel arm 7 is pivotally connected to the second gear 4 via a pin 6. The second swivel arm 9 is pivotally connected to the first swivel arm 7 via a pin 8. A shaft 12 is fixedly secured at a shaft first end 10 to the second swivel arm 9. The shaft 12 is pivotally attached at a shaft second end 28 to the third swivel arm 16. The shaft 12 is housed within the angled neck 29 and is generally parallel with the longitudinal axis 39.

A guide spacer 11 is located within the angled shaft 29 and surrounds the shaft 12 adjacent the first end 10 of the shaft 12 to minimize lateral movement of the shaft 12. A second guide spacer 13 is located adjacent the second end 28 of the shaft 12 to also minimize lateral movement of the shaft 12. Guide spacers 11, 13 align the shaft 12 within the angled shaft 29 and minimize its movement from side to side within the angled shaft 29.

The third swivel arm 16 has a first end 15 and a second end 18. The third swivel arm 16 is pivotally connected to the second guide spacer 13 at the first end 15 via a pin 14. The third swivel arm 16 is connected at the second end 18 to the bristle supporting structure 24 via a pin 19. The pin 19 is connected to a disk 21 of the bristle supporting structure 24 which is housed within the head 23.

As the first gear 2 rotates, the second gear 4 is rotated, thus moving the lower end of first swivel arm 7 in a circular fashion about the circular path of movement of pin 6 as the opposite upper end of the first swivel arm 7 moves in a linear reciprocating motion generally along the longitudinal axis 39. The first swivel arm 7 retains its orientation of approximately parallel to the longitudinal axis 39 of the elongated body portion 30 during movement. The second swivel arm 9 pivots with respect to its pin connection 8 with the first swivel arm 7 thus allowing the shaft 12 to reciprocate in a back and forth manner toward and away from the brush head with minimal lateral motion.

During operation, the third swivel arm 16 moves back and forth along the longitudinal axis 39 of the elongated body portion 30 along with the shaft 12. The third swivel arm 16 has an offset arm 17 which is offset from the longitudinal axis 39 and moves the disk 21 of the bristle supporting structure 24 in a partially rotating or oscillating motion. As the third swivel arm 16 moves back and forth, the offset arm 17 moves along an outside edge 20 of the disk 21 in a partially rotating or oscillating fashion about an axis which is approximately normal to the longitudinal axis 39. This causes the bristles 25 to also move in a partially rotating or oscillating manner about a central rotational axis 102 approximately normal to the longitudinal axis 39. When the third swivel arm 16 moves back and forth, the disk 21 rotates about the central rotational axis 102. The third swivel arm 16 also retains its orientation of approximately parallel to the elongated body portion longitudinal axis 39 during movement.

The head 23 has a first end 26, a second end 22 and a bottom plate 34. The bristle supporting structure 24 is movably fitted to the head 23 and extends through the bottom plate 34. The bristle supporting structure 24 oscillates about the central rotational axis 102 and has bristles 25 which extend outwardly and generally parallel to the central rotational axis 102.

Referring to Figs. 1B, 1C and 1D the swivel arm 16 is pivotally attached to a rotatable disk 21 by a pin 19. When the swivel arm 16 moves back and forth, bristle member 101 is rotated and counter-rotated. A solid threaded cylinder 38 is attached to disk 21 at one end and to a circular bristle supporting structure 24 at the opposite end. Tufts of bristles 25 are arranged in a

circular pattern on bristle supporting member 24. A hollow cylinder 35 (having threads 36 on its internal walls) is attached to bottom plate 34 of brush head 23. Central axis of disk 21, cylinder 38 bristle supporting structure 24 and cylinder 35 is the same. When the disk 21 rotates, threads 37 on solid cylinder communicate with internal threads 36 in hollow cylinder 35 and cause bristles 25 to move up and down (relative to the bottom plate 34 brush head 23) while oscillating through an arc of partial rotation. Fig. 1C illustrates the bristles 25 in an "up" position with the swivel arm 16 pulled back. Fig. 1D illustrates the bristles 25 in a "down" position with the swivel arm 16 extended and end of swivel arm 18 pivotted down while disk 21 is in a rotated position.

A second preferred embodiment is illustrated in Fig. 2A. A threaded solid cylinder 41 is attached to the top plate 40 of the brush head 23. A hollow cylinder 42 (having threads 36 on its internal walls) is attached to the disk 21. When swivel arm 16 (not shown) moves back and forth, disk 21 rotates and counter-rotates. When the disk 21 rotates threads 37 on the solid cylinder 41 communicate with threads 36 in the hollow cylinder 42 to cause the bristles 25 to move up and down while oscillating through an arc of rotation about central rotational axis 102. Fig. 2B illustrates an alternative arrangement in which a hollow cylinder 44 is attached to top plate 40 of brush head 23 and has threads 38 in its internal walls. A solid cylinder 45 is attached to disk 21 and has threads 37 on its external walls. When disk 21 is rotated, bristles 25 move up and down (while oscillating/rotating) when the threads 37 communicate with threads 38.

A third preferred embodiment is illustrated in Fig. 3. The outer edge of rotatable disk 21 has threads 46. The inside wall of brush head 23 also has threads 47 adapted to communicate with the threads 46 of the rotatable disk 21. When swivel arm 16 (not shown) moves back and forth disk 21 rotates and counter-rotates. When the disk 21 rotates and counter-rotates, bristles 25 move up and down while oscillating through an arc of rotation about the central rotational axis 102.

A forth preferred embodiment is illustrated in Figs. 4A, 4B, 4C, 4D, and 4E. Referring to Figs. 4A and 4C protruding ramps 49, located on the top surface of the bristle supporting structure 24, slide in and out of grooves 50 located on bottom surface of floor 34 of brush head 23. When the disk 21 is rotated and counter-rotated, protruding ramps 49 slide in and out of grooves 50 and force the bristle supporting structure 24 to move up and down in a linear reciprocating motion. A spring 48 lifts bristle supporting structure 24 toward bottom surface 34. Fig 4D illustrates the bristles 25 in an "up" position where the ramps 49 are entirely fitted into grooves 50 and the spring 48 is in its relaxed state. Fig 4E illustrates the bristles 25 in a "down" position where disk 21 is rotated, the ramps 49 have moved out of grooves 50, and the spring 48 is in its compressed state. Accordingly, as the disk 21 is rotated and counter-rotated by movement of the swivel arm assembly, the bristle supporting structure and bristles 25 are moved in the oscillating motion through an arc of rotation about the rotational axis 102, while

simultaneously moving in the linear reciprocating motion parallel to the central rotational axis 102.

A fifth preferred embodiment is illustrated in Fig. 5A. Swivel arm 16 is attached to a toothed rack 53. Rack 53, generally parallel to swivel arm 16, moves back and forth when the swivel arm 16 moves back and forth. Teeth 54 on rack 53 communicate with teeth 52 on spur gear 51 to cause gear 51 to rotate and counter-rotate when the rack 53 moves back and forth. The gear 51 is attached to a hollow cylinder 38 having threads 36 on its internal walls. Hollow cylinder 38 is attached to bristle-supporting structure 24 at one end and couples with threaded solid cylinder 41 at opposite end. When the gear 51 is rotated and counter-rotated, threads 37 of solid cylinder 41 communicate with threads 36 on hollow cylinder 38 to move the bristles 25 up and down while simultaneously oscillating about an arc of rotation on the central rotational axis 102. An alternative arrangement is illustrated in Fig. 5B. A hollow cylinder 35 has threads 36 on its internal walls and is attached to floor 34. A solid cylinder 38 having threads 37 on its walls is attached to gear 51 at one end and bristle supporting structure 24 at the opposite end. When rack 53 moves back and forth, threads 37 communicate with threads 36 and cause bristles 25 to move up and down while simultaneously oscillating through the arc of rotation about the central rotational axis 102.

A sixth preferred embodiment is illustrated in Figs. 6A - 6F. In this embodiment, swivel arm 16 is attached to a structure having two parallel toothed rack arms (first rack arm 58 and

second rack arm 60). First rack arm 58 is laterally offset from the second rack arm 60. Teeth 59 of first rack arm 58 are adapted to communicate with teeth 63 of an upper spur gear 62 and to engage the upper gear 62 in order to rotate and counter-rotate the gear 62 about the central rotational axis 102 when the rack arm 53 moves back and forth. Teeth 61 of second rack arm 60 are adapted to communicate with teeth 52 of the lower spur gear 51 to engage the lower gear 51 to rotate and counter-rotate on the same central rotational axis 102 when the rack arm 60 moves back and forth. A first hollow cylinder 55 having threads 37 on its external surface is attached to upper gear 62. One end 79 of first set of tuft of bristles 56 is adapted to be permanently fitted into hole 80 of first hollow cylinder 55. A second hollow cylinder 38 having threads 36 on its internal walls is attached to lower gear 51. Circular bristle supporting structure 24 accommodating second set of bristles 25 is attached to second hollow cylinder 38. When the swivel arm assembly moves back and forth, first and second rack arms (58 and 60 respectively) move back and forth and engage gears 51 and 62, respectively, to rotate and counter-rotate (in opposite directions from one another), thereby causing first and second set of bristles 56 and 25, respectively, to rotate and counter-rotate (in opposite directions from one another). Threads 36 and 37 on the cylinders (38 and 55 respectively) communicate to move up and down the first sets of bristles 56 while simultaneously moving up and down the second set of bristles 25 (in an opposite direction from the first set 56). Fig. 6B illustrates the first set of bristles 56 in a "down" position while the second set of bristles is in an "up" position. In this state, the first set of

bristles 56 extends to its maximum length to penetrate interproximal crevices, while the second set of bristles 25 withdraws to its minimum length to allow the first set of bristles 56 to achieve its maximum penetration. Fig. 6C illustrates the first set of bristles 56 in an "up" position, while the second set of bristles is in a "down" position. In this state the second set of bristles 25 is projected to its maximum length to clean tooth surfaces, while first set of bristles 56 is withdrawn to its minimum length. Fig. 6D is a top plan view of the rack arms 58 and 60. Fig. 6E is a bottom plan view illustrating the relationship between the first set of bristles 56 with cylinder 55, bristle supporting structure 24, and the second set 25. Fig. 6F illustrates an alternative in which hollow cylinder 55 telescopically slides into hollow cylinder 38. The threads 37 of solid cylinder 41 communicate with threads 36 of cylinder 55 to move the first set of bristles 56 in an up and down direction while rotating. Threads 96 of a hollow cylinder 35 communicate with threads 97 on external wall of cylinder 38 to move the second set of bristles 25 in an up and down motion while rotating.

A seventh preferred embodiment is illustrated in Fig. 7. The swivel arm 16 has two side arms (first side arm 65 and second side arm 66) that are pivotally attached to swivel arm 16 thereby allowing end (that end which is attached to disks 64 and 21 respectively) of side arms 65 and 66 to move laterally up and down. First side arm 65 is pivotally attached to top disk 64 and is adapted to rotate and counter-rotate top disk 64 when it (65) moves back and forth. Second side arm 66 is pivotally attached to bottom disk 21 and rotates bottom disk 21 when it (66)

moves back and forth. A hollow cylinder 38, attached to lower disk 21, has threads 36 on its internal walls. Solid cylinder 55, attached to upper disk 64, has threads 37 on its external walls. When swivel arm 16 moves back and forth, movement of side arms 65 and 66 causes upper and lower disks (64 and 21 respectively) to rotate (in opposite directions from one another). Threads 37 on solid cylinder 55 communicate with threads 36 on hollow cylinder 38 to move first and second set of bristles (56 and 25 respectively) up and down (in opposite directions from each other), while rotating about the central rotational axis 102 (in opposite directions from each other). An O-ring 99 is fitted within hole 43 to provide a seal between the hole 43 and cylinder 38, thereby preventing entry of water and foreign material into the interior of the brush head 23 during operation.

An eighth preferred embodiment is illustrated in Figs. 8A, 8B, 8C, and 8D. Sets of bristles 56 are arranged in parallel rows on bottom plate 34 of brush head 23. Swivel arm 16 moves back and forth to rotate a disk 70 which is attached to a drive gear 67. The proximity and arrangement of adjacent spur gears 68 in relation to the drive gear 67 causes the adjacent gears 68 to rotate when the drive gear 67 rotates. A first hollow cylinder 55 attached to adjacent gears 68 has threads 37 on its external walls. A tuft of bristles 56 is permanently fitted into bottom of hollow cylinder 55. A second hollow cylinder 36 having threads 35 on its internal walls is attached to floor 34 of the brush head 23. Referring to Fig. 8C shaft end 87 of shaft 73 protruding from center of disk 70 fits into hole on top plate 40 to minimize sideway movement of drive gear

67 when the disk 70 rotates. Opposite end 74 of shaft 73 fits in hole 88 on bottom plate 34. Refering to Fig. 8A, a middle plate 69 has holes 72 positioned to allow shafts 71 extending from center of gear 68 to move up and down and provide alignment to the gears during rotation. Plate 69 has a large hole 90 to allow the drive gear to be inserted and positioned with adjacent gears 68 during assembly. When the adjacent gears 68 are rotated and counter-rotated threads 37 on the solid cylinder 55 communicate with threads 35 of the hollow cylinder 36 to move the tuft of bristles 56 up and down while rotating. Adjacent tuft of bristles 56 are in opposite (up or down) position. Fig 8B is a top plan view with the top plate removed illustrating the relationship of the drive gear 67 with adjacent gears 68. Fig 8C is a sectional view taken along line 8C-8C in Fig. 8B illustrating the disk 70, drive gear 67, adjacent gear 68 and plate 69. Fig. 8D is a side view illustrating the drive gear 67 in relation to the adjacent gears 68 and the up or down positions of bristles 56.

A ninth preferred embodiment is illustrated in Figs. 9A, 9B, and 9C. Swivel arm 16 is attached to a rack member 75 having teeth 91 on both sides. Teeth 91 on rack member 75 engage drive gears 92 to rotate when the rack member 75 moves back and forth. The proximity and arrangement of adjacent gears 68 cause adjacent gears 68 to counter-rotate when the drive gear 92 rotates. Referring to Figs. 9B and 9C a hollow cylinder 93 attached to top plate 40 of the brush head 23 has threads 36 on its internal walls. A solid cylinder 95 having threads 37 on external walls is attached to gears 92 and 68. Tuft of bristles 56 are permanently fitted into

hollow cylinder 98. When the rack 75 moves back and forth, drive gears 92 and adjacent gears 68 are rotated and counter-rotated. Threads 36 in the hollow cylinder 93 communicate with threads 37 on the solid cylinder 95 to move the bristles 56 up and down while rotating. Fig. 9C is a side view illustrating the rack 75 in relation to drive gears 92 and adjacent gears 68 and up and down positions of tuft of bristles 56.

A tenth preferred embodiment is illustrated in Figs. 10A, 10B, 10C, and 10D. Pairs of tufts of bristles (56 and 25) are arranged in parallel rows on bottom plate 34 of brush head 23. Referring to Figs. 10B and 10C swivel arm 16 is attached to a rack-supporting structure having three parallel rack arms (81, 83, and 82). The middle rack arm 83, laterally offset from the two side rack arms (81 and 82), is adapted to engage the upper gears 62 to rotate when the rack arm 83 moves back and forth. The two side rack arms (81 and 82) are adapted to engage lower gears 52 to rotate when the rack arms (81 and 82) move back and forth. Referring to Figs. 10C and 10D a first hollow cylinder 55, attached to upper gear 62, has threads 37 on its external walls, and is adapted to permanently fit first set of bristles 56 (designed to access interproximal crevices between teeth). A second hollow cylinder 38, attached to lower gear 52, has threads (not shown) on its internal walls. Bristle supporting structure 24 is attached to second hollow cylinder 38. Second set of bristles 25 (designed to clean tooth surfaces) is attached to bristle supporting structure 24. A shaft 71 protrudes from center of gear 62 and fits in hole in upper plate 40 to prevent sideway movements of gear 62 during rotation. When swivel arm 16 moves

back and forth, middle rack arm 83 engages upper gears 62 to rotate and counter-rotate while both side rack arms 81 and 82 engage lower gears 52 to rotate and counter-rotate (in opposite direction of upper gear 62). Threads on the two cylinders (38 and 55) communicate to move the first set of bristles 56 up and down (in opposite direction of movement of second set of bristles 25) while rotating.

While the present invention has been shown and described in accordance with various preferred and practical embodiments, it is recognized that departures from the instant disclosure are fully contemplated within the spirit and scope of the invention without limitation, except as set forth in the following claims as interpreted under the doctrine of equivalents.